Module 9
Hydrological Information System

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Keywords: Hydrological Information System, Design, Data, Transmission, Storage, Retrieval, Dissemination, Human Resources

The objectives of this module are:

- To define a hydrologic information system and explain the need of it.
- To explain the key features of a HIS.
- To discuss other topics related with HIS.

9.1 HYDROLOGICAL INFORMATION SYSTEM

The occurrence of water shows great variability in space and time and requires that adequate measurement networks are established to define spatial variability and that they are maintained over a sufficient period of time to define temporal variability of a water variable. Management of water services for domestic, industrial, agricultural and power generation - and protection from the vagaries of floods and droughts, requires information on storages and fluxes of water.

A Hydrological Information System (HIS) consists of the physical infrastructure, software and human resources to collect, process, store and disseminate data on hydro-meteorological, hydrological, geo-hydrological and related variables. The physical infrastructure includes the data observation networks, laboratories for analysis of samples, communication systems, and data storage and processing centres. The human resources are the trained staff who observe, key-in, process, disseminate the data and maintain the equipment computers, etc.

The primary role of a HIS (see Fig. 9.1) is to provide reliable data sets for planning, design and management of water resource and for research activities. The system should function
in such a manner that it provides the information to users in time and in proper form. Sometimes, the scope of HIS is extended to provide data to users on a real-time basis for short-term forecasting or operational purposes.

The data collected for different hydrometeorological variables is called the raw or observed data. The raw data have to be processed to ensure the reliability of the resulting information. Both raw and processed data sets have to be properly stored -- processed data for dissemination and raw data to permit inspection and revalidation in response to queries from users. Note that the users have a central role in a HIS.

![Diagram of a hydrological information system]

**Fig. 9.1** Schematic diagram of a hydrological information system.

Since most of water-related development activities are controlled by the government sector in India, the main agencies that observe hydrometeorological data are the users themselves (HP 2003). Therefore, the network and frequency of data collection are governed by their own needs. Other data users, such as researchers, may find that data, if available, are inadequate in spatial and temporal coverage, are of varying/inadequate reliability and are scattered at many locations. Importantly, the data that is once missed is not available later on. To obviate all these, there must be a strong linkage between data collectors and the end users and a periodic review of the HIS.

Inadequate data may result in costly construction with an unnecessary high margin of
safety or with the equally costly consequences of failure. Ideally there must be a strong linkage between data/information producers and users, who can be from within the same organization and external users from other agencies, consultants, research scholars, etc.

9.1.1 Functions of a HIS
The functions of a Hydrological Information System are contained in the title itself.

Hydrological: Hydrology is the science of water and is concerned with its states, storages and fluxes in location, time and phase. Hydrometry is the branch of hydrology which is concerned with the measurement of these states, storages and fluxes in the water cycle.

Information: is data which has been and processed to remove errors and is presented in a meaningful way. By definition, information serves a function and is created with some purpose. Three key features of information are: reliability, availability and presentation.

System: The HIS is a logical and structured system to collect data which are subsequently entered into the computer, checked and stored. In a HIS, data may be associated, related and combined to provide information in a form suitable to users.

The activities under HIS can be broadly classified in the following categories:

i. Assessing the user needs;
ii. Establishing an observational network and operating it;
iii. Data collection, validation, processing, and reporting;
iv. Management of historical data;
v. Data transmission, storage, and dissemination; and
vi. Institutional and human resource development.

9.2 Designing a HIS
The primary role of a HIS is to provide reliable data sets for a variety of purposes: planning, design and operation of water resources development projects; formulating policies of utilization of water resources; and for use in research activities. The system should be able to provide the requisite information to the users in time and in a usable format. Some modern HIS also provide
data to the users in (near) real-time. To perform these roles, the activities under a HIS can be broadly classified in the following categories:

- Assessing the needs of users,
- Establishing and running observational network in accordance the needs and applicable standards,
- Data collection, processing, analysis and storage,
- Management of historical data,
- Data dissemination,
- Data Exchange and reporting,
- Institutional and human resource development.

A HIS should be designed so that it can carry out all these tasks in as efficient manner.

9.2.1 Assessing the needs of users

In any information system, the first question to be answered is what type of data are to be provided to the users. Answer to this question determines the layout of the observation network (parameters, network density, observation frequency, equipment, etc.) and the data to be stored in the database. Of course, this question is largely answered for a HIS by the definition itself. To assess the needs of data users, it is necessary to regularly interact with them. A successfully tested way to formalize this is through a Hydrological Data User Group (HDUG). Potential data users and those who are responsible to implement HIS are members of these HDUGs. These HDUGs should meet regularly to review hydrological data needs, identify shortfalls, and make suggestions for improvements.

In India, many Central and State Government organizations are the major users of the hydrologic data. There are scores of other governmental, nongovernmental and private agencies also who use this information. Usually there is a direct link between the objectives of water resource management and the type of data needed from the Hydrological Information System. Due to various reasons, hydrological data needs of the users change with time. Therefore, it is very important to identify the potential data users and regularly update their data needs. Normally, it is expected that the hydrological information service agencies will satisfy most of the genuine data needs of the potential users. For ensuring an optimal use of the public resources spent for maintaining a Hydrological Information Service, it is essential to have a proper balance between the data needs of different users and mandate of various services supporting HIS.

Often, it is assumed that the information being provided is the same as required by the potential users. User’s needs may change with time and the HIS would fulfill its obligations only if there is a continual review of the changing needs of the users.

After finalizing the objectives of the HIS, the observational network has to be planned and established. This aspect has been discussed in a previous module. It is important to ensure
that the observation networks of different agencies are properly integrated so that duplication of efforts is avoided.

9.2.2 Data Transmission

WMO (1994) has given the classification of data transmission systems:

1. Manual with the observer at a station sending data to the central office.
2. Manual/semi-automatic system where the central office manually interrogates the automatic field stations through telephone, radio, etc. and receives the data.
3. Pre-program and time system where automatic equipment initiates the transmission of observations.
4. Automatic event indicator and the station automatically transmitting the specified change of variable to a central location.
5. Automatic system with station transmitting and central office recording data continuously.

The possible choices of transmission links are:

a) Telephone lines are used wherever feasible. With improvements in information technology, high rates of data transmission are possible.
b) High frequency radio links are used when land lines are not available or topography is difficult. The installation cost can be high.
c) A significant development of last few decades has been the use of mobile telephony or satellites for data transmission. A satellite-based system consists of Data Collection Platforms (DCP) that are installed at hydrometeorological stations. DCPs are (rechargeable) battery-operated devices that collect, encode, and communicate the data of the station to a central location through a satellite link at pre-determined time/frequency. Solar panels are frequently employed to generate energy. This system is very useful for remote and difficult-to-access locations.

A particular transmission system is adopted depending on a) the frequency of data observation and the urgency of data, b) the additional benefits of having forecasts based on telemetered data, c) robustness and reliability of the system, particularly in inclement weather, and d) availability of finances, infrastructure and manpower to efficiently run the system.

With growth in information technology, the trend is towards automatic observation, transmission and storage of data. The practices are undergoing rapid changes with technology. Multi-parameter data loggers can measure, store, and transmit data observed by several observation sub-systems. These days, the data loggers are small, rugged, and have small power
requirement. These may be battery or solar-power operated. WMO has evolved codes related to hydrometeorological data. They have also launched an elaborate system for data observation and transmission through the World Weather Watch (WWW) programme (www.wmo.ch/web/www).

9.3 Hierarchy of HIS
In India, the HIS may also be viewed as hierarchical system, operating at different levels of sophistication from measurement in the field to national and/or agency level processing, storage and data dissemination centres. A typical flow of data is as follows (HP 2003):

- **At the observation stations** relevant data and water quality samples are collected. Samples are sent to Water Quality Laboratories. At regular intervals (say, monthly) the collected data are sent to the next higher office which may be the sub-divisional/District Data Processing Centre.

- **In the Sub-divisional/District Data Processing Centres** all data received from observing stations are entered in the computer and stored in a temporary database. Primary validation is carried out and then the data are passed on to the Divisional/Regional Data Processing Centre. If necessary, feedback is given to those observing the data.

- **Water samples are analysed in the Water Quality Laboratories.** The analysis results are entered in the computer and subjected to primary validation. At regular intervals, the laboratory passes the information on to the nearest Divisional or Regional Data Processing Centre.

- **In the Divisional/Regional Data Processing Centres**, given their larger spatial coverage, more advanced secondary data validation is carried out. After validation, the surface water and groundwater data are transferred to their respective State Data Processing Centres.

- **State Data Processing Centre** carries out final data validation, completion, analysis and reporting. Here, the data are stored in temporary databases. At the end of the hydrological year, once the data have been properly validated, the (authenticated) processed data is transferred to the State Data Storage Centre. To improve the effectiveness of the final validation, State Centres also uses the relevant data collected by the other organizations.

- **The State Data Storage Centre** stores and administers the storage of all field and (authenticated) processed hydrological data collected in the State, and provides the data available to authorised Hydrological Data Users. As a State archive, it also maintains an HIS-Catalogue of all data stored in its own database and those stored in the databases of the other states and of the Central Agencies.

In some organisations, data collected by the whole network may be kept at a central place. It may be noted that the above is a general descriptions and there may be case specific differences.
It is clear from the above that data processing activities are carried out at more than one level within each agency and this makes it essential to have adequate communication links between them with increasing penetrations internet, data transmission has become quite simple and efficient. The requirement for communication is to be based on a low frequency and high volume of communication. Information is exchanged between various agencies for data validation as surface and groundwater networks are operated by different state and central agencies.